

# Parent's self-reported indoor environment-related symptoms and health worry increase symptom reports among their children at school—Study in two independent populations

Sanna Selinheimo<sup>1</sup>  | Jussi Lampi<sup>2</sup> | Juha Pekkanen<sup>2,3</sup> 

<sup>1</sup>Finnish Institute of Occupational Health, Helsinki, Finland

<sup>2</sup>Environmental Health Unit, National Institute for Health and Welfare, Kuopio, Finland

<sup>3</sup>Department of Public Health, Faculty of Medicine, University of Helsinki, Helsinki, Finland

## Correspondence

Sanna Selinheimo, Finnish Institute of Occupational Health, Topeliuksenkatu 41 b, 00250 Helsinki, Finland  
Email: sanna.selinheimo@ttl.fi

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## Abstract

Little is known whether parent's indoor environment quality (IEQ)-related symptoms or health perceptions influence the risk of self- or parent-reported symptoms in their children. We assessed (i) the association of parents' IEQ-related symptoms with IEQ-related symptoms in their children at school and (ii) whether parental IEQ-related health worry increases the risk for children's symptoms. We used two Finnish studies: a national, population-based survey of indoor air and related health problems ( $n = 611$  parents) and a subset of survey for all primary school pupils (grade 3–6) and their parents in Helsinki, which also included school IEQ-related symptoms reported by children ( $n = 1617$  parent-child dyads). In the school survey, parent's own symptoms increased strongly their reporting of their children's symptoms at school (aOR 4.0, 95% CI 2.7–6.0 for parents experiencing a lot of symptoms) and also symptoms reported by the child itself (aOR 2.2, 95% CI 1.5–3.1). Similar, but slightly weaker associations were seen with parental IEQ-related health worries. Results remained unchanged when adjusted for the IEQ of school buildings or parental and children's allergic diseases. Similar associations were seen in the national survey between parent's symptoms at work and child's symptoms at school. The results suggest that parents' health perceptions may increase the reporting of children's IEQ-related symptoms even more than is typically seen for many indoor air contaminants.

## KEYWORDS

health perceptions, health worry, indoor environment quality, symptom reporting, symptoms

## Practical implications

- Parents' health perceptions appear to influence reporting of children's indoor environment-related symptom, which may bias findings from indoor air surveys.
- The association between parent's health worry and symptoms of their children was stronger when parents also reported the children's symptoms. This supports the use of questionnaires administered directly to the children.
- More attention should be placed both in future research and practice on the social context which strongly influences the individuals' ways of interpreting and perceiving IEQ-related symptoms.

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## 1 | INTRODUCTION

Various indoor environment quality (IEQ)-associated adverse health effects, ranging from frequently reported comfort complaints to rare multiple persistent physical symptoms and disability, emerge in both non-industrial work environments and in schools across Europe.<sup>1-4</sup> Consistent associations between indoor environment problems—such as severe moisture and mold damage in indoor environment or insufficient ventilation—and increased symptom prevalences have been shown,<sup>5-7</sup> but evidence of causality between these factors has not been established.<sup>6-8</sup>

Individual and psychosocial risk factors have also been shown to predict increased symptom reports related to indoor environmental factors.<sup>9-12</sup> Previous research shows that a poor psychosocial climate in work environment, in terms of work stress, lack of control over one's work situation, and low support from supervisors at work or from teachers at school, associate with increased IEQ-related adverse health effects.<sup>10,13-16</sup> It has been suggested that psychosocial factors are more important determinants of IEQ-related symptoms than measured IEQ.<sup>10</sup> Therefore, more attention should be placed on these factors that modify individuals' ways of interpreting and perceiving symptoms, that is, health perceptions and beliefs about health.

Very little is known of “transmission” of IEQ-related symptoms between individuals. Parental ways to respond to children's health complaints and ways in which they model illness behavior influences their children's illness perceptions and beliefs about health.<sup>17</sup> Therefore, an important research question is whether parent's IEQ-related health worries influence their perceptions of their child's health. Parental health-related preoccupation and excessive thought of their own disease have recently been shown to associate with poor reported health outcomes in their children.<sup>18,19</sup> Thorgaard et al.<sup>20</sup> showed that parent's excessive worries about health associate with conceiving their child more ill than parents without these concerns and excessive parental health worries have been shown to associate with children's health-related worries.<sup>21,22</sup> There are also some data available that parental health worries related to environmental factors associate with adolescents' health worries and risk for misinterpreting bodily sensations.<sup>23,24</sup> Further, a recent study showed that children's IEQ-associated symptom reports are influenced by parental health perceptions related to IEQ.<sup>25</sup> Thus, parental environment-related health worries may affect their reports of their children's health, and potentially also child's own health perceptions. Although mechanisms of intergenerational transmission of parental health and health attitudes are recognized, studies are scarce on IEQ and symptoms in children.

The aim of this study was to examine the association between parental IEQ-related symptoms and child's school IEQ-related symptoms, reported by the parent and by the child itself. We hypothesized that there would be a significant, positive relationship between parent's self-reported health complaints related to IEQ and children's IEQ-related symptoms at school. As parental worry

of school IEQ has been shown to be associated with increased symptoms reports in children,<sup>25</sup> we further hypothesized a similar association between parent's IEQ-related health worry and children's symptoms.

## 2 | MATERIAL AND METHODS

Two independent and cross-sectional datasets were used: a subset of the Survey of Indoor environmental quality and symptom reporting in schools in Helsinki (School study)<sup>26,27</sup> and a population-based National survey on indoor air (National survey study).

### 2.1 | Study populations

#### 2.1.1 | The questionnaire survey in schools in Helsinki

A cross-sectional survey of indoor environmental quality and symptom reporting was conducted in all primary schools in Helsinki, Finland, in 2016–2018.<sup>26,27</sup> The present study uses data from the surveys conducted in 2017 and 2018. The survey conducted in winter 2017 consisted of all 33 primary schools in northern, western, and northeastern regions of Helsinki, and the survey conducted in winter 2018 consisted of all 43 primary schools in eastern regions, as well as in all Swedish-speaking schools of Helsinki. The first survey conducted in 2016 was excluded from the present analyses, as it used a shorter version of the parental questionnaire than later surveys.

In primary schools, all 3- to 6-grade pupils and parents of 1- to 6-grade pupils were invited to participate in the survey. In primary schools, pupils filled in the electronic questionnaires in classrooms under the teachers' supervision. Parents were instructed to answer the structured electronic questionnaires about symptoms and health conditions. The response rate of 3- to 6-grade pupils was 68% in 2017 and 57% in 2018; whereas the response rate of primary school-aged pupils' parents' was low (20% in 2017 and 13% in 2018). Participation in the survey was voluntary, and parents could refuse the use of their children's information ( $n = 6$  parents refused the use of information).

For this study, we included only those 3- to 6-grade pupils, whose parents also had filled in the questionnaire. Further, schools with special education, the school buildings in which there were <10 responses per building or expert evaluation of IEQ problems was missing, were excluded. Thus, this study included the following number of participants: 1617 parent-pupil data pairs from 69 schools.

The prevalence of symptoms reported by pupils and parents in this restricted dataset was practically identical compared with all 8775 pupils and 3540 parents, who took part in the surveys in 2017–2018.<sup>26</sup> As no personal identification data were collected from the parents, it is impossible to know, if the same parent gave data for

several siblings. However, we tried to estimate the proportion of such occurrences in the dataset based on the pupils' last name and data given in the parental questionnaire on respondent's and home's characteristics. We found that approximately 87%–94% of the data consisted of parent-child dyads, where the parent had filled in only one questionnaire.

In addition to questionnaires to the parents and pupils, an expert evaluation of school building IEQ was conducted, as described previously.<sup>26,27</sup> This assessment included (a) moisture and mold damage, (b) insufficient ventilation, (c) unsatisfactory temperature conditions, (d) building structures with high risk of moisture damage, (e) strong smell of mold or other strong smells, (f) extensive coating damage and emission due to moisture damage in concrete floor structures, (g) mineral fibers in building or in the ventilation system and (h) other significant impurities in the ventilation system. The evaluation followed a comprehensive system for assessing indoor air problems at workplace, taking into account Finnish legislation and guidelines.<sup>28,29</sup> The assessment was based on all existing technical data from each school building, but no special visits were done. Before the questionnaire survey, the experts reached a consensus concerning the relative rating of the school buildings. Using latent class analyses, a summary score of IEQ problems in schools was created (class 1: "good IEQ," class 2: "moderate IEQ," class 3: "poor IEQ" and was found to be associated with symptom reporting.<sup>26,27</sup>

Further information of the study protocol and summary of the baseline data have been shown previously.<sup>26,27</sup>

## 2.2 | Parent-administered questionnaire—The questionnaire survey in schools in Helsinki

### 2.2.1 | Parent's IEQ-related symptoms and health worries

All parents were asked whether 'moisture and mold damage usually cause them some type of symptoms (eg, respiratory or eye symptoms, headache, feeling unwell)'. The question had five response options (1 = "not at all," 2 = very little, 3 = some, 4 = quite a bit, 5 = "very much"). In the analysis, the answers were classified into four categories ("0" = "no at all," 1 = "very little," 2 = "some," 3 = "quite a bit and very much").

Parental IEQ-related health worries were measured using the question "In general, how great a risk do you consider an exposure to water damage in other buildings (home excluded) pose to human health in Finland?". The question had five response options (0 = "no risk at all," 1 = "minor risk," 2 = "moderate risk," 3 = "severe risk," and 4 = "very severe risk"). In the analysis, the answers were classified into three categories ("0" = "no risk at all or minor risk," 1 = "moderate risk," 3 = "severe or very severe risk"). Same coding was used for the question "In general, how great a risk do you consider an exposure to water damage in other buildings (home excluded) pose to

your health?", which was used in analyses assessing the robustness of the results.

### 2.2.2 | Children's symptoms

The questionnaire included 18 questions related to children's respiratory symptoms and other symptoms in the past 4 weeks. Symptoms were classified into five symptom groups: respiratory, lower respiratory, eye, skin, and general symptoms. All survey respondents were also asked whether they think the symptoms from the five above-mentioned symptom groups are especially related to the school environment. In the present analyses, the child was considered to have parent-reported school IEQ-related symptoms, if both of the following criteria were met: (i) the parent-reported symptoms from at least one of these five symptom groups and (ii) related the corresponding symptom group to school IEQ. These child's parent-reported school IEQ-related symptoms were coded as "1" and the rest as "0" (no symptoms or symptoms for other reasons).<sup>26,27</sup> A detailed description of the symptom coding and analyses have been described in detail previously.<sup>26,30</sup>

## 2.3 | Pupil-administered questionnaire—The questionnaire survey in schools in Helsinki

### 2.3.1 | Children's symptoms (3- to 6-grade pupils)

The questionnaire included 10 questions related to child's respiratory symptoms and other symptoms in the past 2 weeks. Symptoms were classified into five symptom groups: respiratory, lower respiratory, eye, skin, and general symptoms. The children were also asked whether they think the symptoms from the five abovementioned symptom groups are especially related to the school environment. In the present analyses, the child was considered to have child-reported school IEQ-related symptoms, if (i) the child-reported symptoms from at least one of these five symptom groups and (ii) related the corresponding symptom group to school IEQ (coded as "1" and the rest as "0"). The symptom analyses have been described in detail previously.<sup>26</sup>

## 2.4 | Covariates – The questionnaire survey in schools in Helsinki

The demographics (child's age and gender), allergic diseases of the child during past 12 months (allergic rhinitis, atopic dermatitis, and asthma), socioeconomic status measured by the type of accommodation ownership and smoking in the family reported by the parent were used as confounders in the analysis of the School study dataset. Furthermore, the summary score on indoor environmental quality based on technical data<sup>26</sup> was used as a confounder. In analyses presented in the Supplement, mother's and father's allergic diseases

(allergic rhinitis, atopic dermatitis and asthma, lifetime diagnosis) and the parent's awareness of school moisture or mold damage during preceding 12 months were used as covariates to assess the robustness of the results.

### 2.4.1 | The National survey on Indoor air

The National survey on indoor air was conducted by the Finnish Institute for Health and Welfare in Finland. The questionnaire data, based on random sampling of Finnish people aged 25–64, were collected from November 2018 to March 2019 in Finland excluding Åland, an autonomous Swedish-speaking area of Finland. The base sample comprised 4997 subjects aged 25–64, of whom 1797 (36%) responded either the postal or electronic questionnaire. The present analyses include data from 611 respondents, who had children below the age of 18.

## 2.5 | Parent-administered questionnaire—The National survey on indoor air

*Parent's symptoms.* Respondents were asked whether they have had symptoms from indoor air at their workplace. The question had three response options (0 = “never,” 1 = “yes, during past 12 months,” 2 = “yes, over 12 months ago”). In these analyses, symptoms were considered to be present (“1”), if they occurred during the past 12 months, otherwise absent (“0”). Respondents were further asked the severity of the symptoms during the past 12 months in five response options (0 = “no symptoms,” 1 = “mild symptoms,” 2 = “moderate symptoms,” 3 = “severe symptoms,” and 4 = “very severe symptoms”), and the answers were reclassified into four categories (“0” = “no symptoms,” 1 = “mild symptoms,” 2 = “moderate symptoms,” 3 = “severe or very severe symptoms”). The severity of the symptoms was further dichotomized as “1” if a respondent had mild to severe symptoms and “0” if the respondent had no symptoms related to workplace indoor air during past 12 months.

### 2.5.1 | Parent's IEQ-related health worry

Worries about adverse health effects related to IEQ were measured using the question “In general, how great a risk do you consider an exposure to water damage at workplace pose to human health in Finland?” The question had five response options (1 = “no risk at all,” 2 = “minor risk,” 3 = “moderate risk,” 4 = “severe risk,” 5 = “very severe risk,” and 6 = “Don't know”). “Don't know” answers were classified as missing. Due to small numbers, the answers were classified into only three categories (“0” = “no risk at all or minor risk,” 1 = “moderate risk,” 2 = “severe or very severe risk”). The same coding was used for the question “In general, How great a risk do you consider an exposure for water damage at workplace pose to your own health?”, which was used in analyses that assess the robustness of the results.

### 2.5.2 | Child's symptoms

Respondents were further asked whether any of their children (Below age of 18 years) have had symptoms related to kindergarten or school indoor air. The question had three response options (0 = “never,” 1 = “yes, during past 12 months,” 2 = “yes, over 12 months ago”). In these analyses, symptoms were considered to be present (“1”), if they occurred during the past 12 months, otherwise absent (“0”).

## 2.6 | Covariates—The National survey on indoor air

The demographics (parent's age and gender), socioeconomic status measured by the type of accommodation ownership and smoking in the family were used as confounders in the analysis of the National survey study dataset. Further, the number of children in the family and respondents' level of education and his/hers self-reported health on five grades of severity (1 = the best level and 5 = the worst level of health) were used also as confounders.

## 2.7 | Statistical analysis

Final analysis in the School—study included 1617 parent-child dyads and the National survey on indoor air—study included 611 subjects. In the National survey study, prevalence of missing data for parents' symptoms was 3.6% ( $n = 22$ ) and parents' risk perceptions 4.9% ( $n = 30$ ). The univariate statistical analyses in both datasets were carried out using Pearson's chi-square test. Multivariate models were run using logistic regression. In the multivariate models, missing data for each confounder were classified in an own category. We assessed the robustness of the results with additional adjustments: Logistic regression analyses were run with stepped adjustments including parents' allergic diseases (Table S1) and parents' awareness of school IEQ problem (Table S2) as covariates in the School study. Further, we adjusted the analyses in both datasets by using a question about health risk related to moisture damage to the respondent's own health (Table S3 the School study and Table S4. the National survey). All analyses were conducted in IBM-SPSS 26.0 for Windows (SPSS Illinois).

## 3 | RESULTS

### 3.1 | The questionnaire survey in schools in Helsinki

The final sample consisted of 1617 parent-child dyads that had completed the questionnaires both for parents and for children. The majority of respondents were mothers (80.0%), mean age of children was 10.5 years (SD 1.2 years), and 54.1% of them were girls. Parents reported that 22.4% of the children had allergic rhinitis, 21.9% had

atopic dermatitis and 5.8% had asthma during past 12 months. In 15.5% of the families, there were active smokers. Parents' IEQ-related symptoms associated strongly and dose dependently with school IEQ-related symptoms in children, either reported by the parents or by the children themselves (Table 1, Figure 1). Further, parental IEQ-related health worries are associated with children's IEQ-related symptoms reported by the parents or by children (Table 1, Figure 2).

Even after several adjustments, parents self-reported symptoms related to moisture and mold damage buildings associated with increased odds of children's school IEQ-related symptoms reported by the parents, (Table 2) and, somewhat more weakly, with symptoms reported by the child (Table 3). The associations were similar when analyses were separately controlled for children's or parents' allergic diseases or parents' awareness of school IEQ problem (Table S1–S2). Parent's IEQ-related health worry associated with an increase in the odds of children's school IEQ-related symptoms reported by parents (Table 2). However, after adjusting for the parent's symptoms the association decreased but remained significant (Table 2). Parents' IEQ-related health worries were also, but more weakly associated

with IEQ-related symptoms reported by their child, and after mutual adjustment for parents' symptoms these associations changed to non-significant values close to 1.0 (Table 3). The associations observed were similar, even stronger, than those associations reported in Tables 2 and 3 when parents' IEQ-related worry considering their own health was used as a predictor after adjustment for further covariates (allergic diseases of the child, parental awareness of school IEQ problem; Table S3.).

### 3.2 | The National survey on indoor air

The final sample consisted of 611 respondents who completed the questionnaire and had under 18-year-old children. Most of the respondents were 30–40 (34.2%) or 40–50 (41.2%) years old, while 8.5% were below 30 and 16.1% were above 50 years old. Of them, 23.2% had higher and 29.1% had middle education, 86.6% evaluated their health status as good or fairly good and 10.3% as average. 15.4% were regular smokers. As regards IEQ-related symptoms, 23.1% reported symptoms from workplace IEQ and 13% reported that their children had symptoms from school IEQ. Parents with symptoms reported overall more school IEQ-related symptoms in their children than parents without symptoms (Table 1, Figure 3). Further, 17.3% reported severe IEQ-related health worry that associated with children's IEQ-related symptoms at school or at kindergarten reported by parents.

After adjustment for all available covariates, parents' symptoms from workplace IEQ are associated with increased risk for reporting symptoms from school IEQ in their children (OR 4.9, 95% CI 2.7–8.6) (Table 4). Similarly, parents' health worry related to water damage at workplace is associated with increased risk for children's school IEQ-related symptoms (OR 3.2, 95% CI 1.4–7.0 for parents experiencing severe or very severe health risk). Again, the results remain robust in the further additional analysis (Table S4).

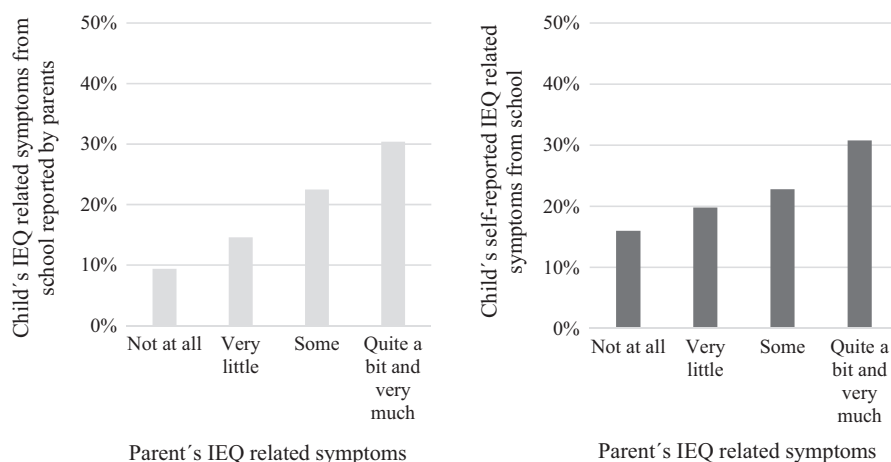
## 4 | DISCUSSION

We found that parents with IEQ-related symptoms reported far more school IEQ-related symptoms in their children than parents without these symptoms in the analyses based on two independent samples. We further found a similar, but weaker, association, if symptoms were reported by children themselves suggesting, that parents' symptom history influences their children's symptom reporting behavior. These findings support our main hypotheses, that parents' self-reported IEQ-related symptoms strongly are associated with their perceptions about their children's health, even independently of the measured IEQ in school buildings or independently of parents' awareness of existing school building IEQ problem. As regards our secondary hypothesis, we found in both datasets that parental health worries are associated strongly with increased IEQ-related symptoms in children reported by parents and, although to a slightly lesser extent, when reported by children themselves in the

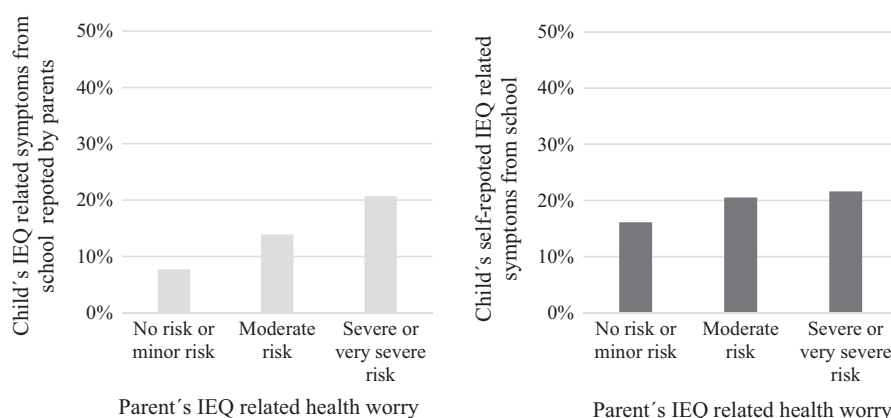
**TABLE 1** Child indoor environment quality (IEQ)-related symptoms at school<sup>a</sup> in two study populations

Datasets	Child's school IEQ-related symptoms				
	N <sup>b</sup>	Parental reporting %		Self-reporting %	
School survey					
Parent's symptoms from moisture and mold damage					
Not at all	700	9.4		16.0	
Very little	378	14.6		19.8	
Some	325	22.5		22.8	
Quite a bit to very much	214	30.4	<0.000 <sup>c</sup>	30.8	<0.000 <sup>c</sup>
Parent's health worries related to water damage					
No risk or minor risk	310	7.7		16.1	
Moderate risk	531	13.9		20.5	
Severe or very severe risk	776	20.7	<0.00 <sup>c</sup>	21.6	0.12 <sup>c</sup>
National survey on indoor air					
Parent's IEQ symptoms at workplace					
No symptoms	450	8.4			
Symptoms	139	28.1	<0.000 <sup>c</sup>		
Parent's health worries related to water damage at workplace					
No risk or minor risk	129	6.2			
Moderate risk	227	12.8			
Severe to very severe risk	225	17.3	0.011 <sup>c</sup>		

<sup>a</sup>National survey on indoor air included child's symptoms related also to kindergarten IEQ.; <sup>b</sup>In School survey N = parent-child dyads; in National survey on indoor air N = parent respondents.; <sup>c</sup>Global chi-square test.



**FIGURE 1** The association between parents' IEQ-related symptoms and children's symptoms related to school IEQ reported both by parents and children in the School survey



**FIGURE 2** The association between parents' IEQ-related health worry and children's symptoms related to school IEQ reported both by parents and children in the School survey

**TABLE 2** Multivariate adjusted predictors of child's indoor environment quality (IEQ)-related symptoms at school reported by parents (N = 1617) in the School survey

	Unadjusted		Adjusted		Unadjusted		Adjusted		Mutually adjusted	
	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI	aOR	95% CI
Parent's IEQ-related symptoms										
Not at all	1		1						1	
Very little	1.6	[1.1, 2.4]	1.5	[1.0, 2.3]					1.4	[0.9, 2.1]
Some	2.8	[1.9, 4.0]	2.6	[1.8, 3.7]					2.3	[1.5, 3.3]
Quite a bit to very much	4.2	[2.8, 6.2]	4.0	[2.7, 6.0]					3.3	[2.2, 5.1]
Parent's health worry related to water damage										
No risk or minor risk					1		1		1	
Moderate risk					1.9	[1.2, 3.1]	1.9	[1.1, 3.1]	1.6	[1.0, 2.6]
Severe or very severe risk					3.1	[2.0, 4.9]	2.8	[1.8, 4.5]	2.0	[1.2, 3.3]

OR, Odds ratio; CI, Confidence interval; cOR, unadjusted analyses; aOR, adjusted analyses; Analyses adjusted by child's age and gender, respondent's (parent-administered questionnaire) gender and smoking in the family, type of accommodation ownership, allergic diseases of the child (allergic rhinitis, atopic dermatitis, or asthma during past 12 months), and school building indoor air quality.

School survey. The additional analyses provide supplementary evidence for these conclusions by indicating that shared environmental or health-related risk factors do not have a strong effect on the reported associations. To our knowledge, this is also the first study

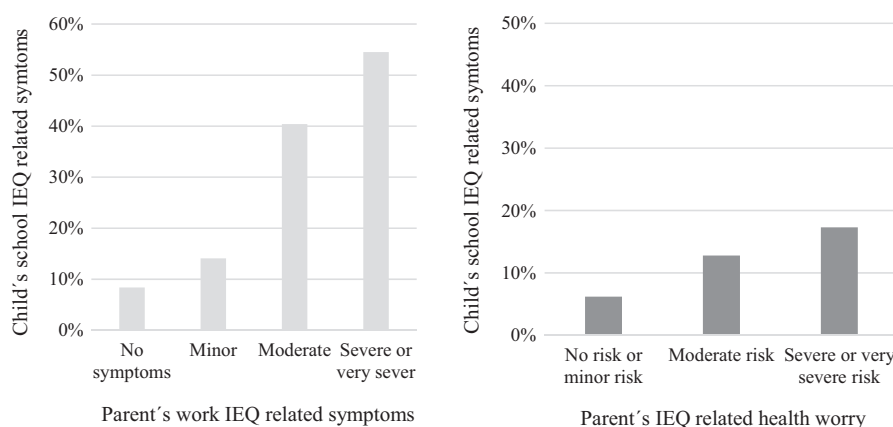
showing that parental IEQ-related symptoms and health worry influence children's health perceptions.

Our results reflect those of Thorgaard et al 2017<sup>20</sup> who showed that parents' with severe health-related worries tend to interpret

**TABLE 3** Multivariate adjusted predictors of child's indoor environment quality (IEQ)-related symptoms at school reported by children (N = 1617) in the School survey

	Unadjusted		Adjusted		Unadjusted		Adjusted		Mutually adjusted	
	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI	aOR	95% CI
Parent's IEQ-related symptoms										
Not at all	1		1						1	
Very little	1.3	[0.9, 1.8]	1.2	[0.9, 1.7]					1.2	[0.9, 1.7]
Some	1.5	[1.1, 2.2]	1.4	[1.0, 2.0]					1.4	[1.0, 2.0]
Quite a bit to very much	2.3	[1.6, 3.3]	2.2	[1.5, 3.1]					2.2	[1.5, 3.2]
Parent's health worry related to water damage										
No risk or minor risk					1		1		1	
Moderate risk					1.3	[0.9, 1.9]	1.3	[0.9, 1.9]	1.2	[0.8, 1.7]
Severe or very severe risk					1.4	[1.0, 2.0]	1.3	[0.9, 1.8]	1.0	[0.7, 1.5]

OR, Odds ratio; CI, Confidence interval; cOR, unadjusted analyses; aOR, adjusted analyses; Analyses adjusted by child's age and gender, respondent's (parent-administered questionnaire) gender and smoking in the family, type of accommodation ownership, allergic diseases of the child (allergic rhinitis, atopic dermatitis, or asthma during past 12 months), and school building indoor air quality.

**FIGURE 3** The association between parents' work IEQ-related symptoms and IEQ-related health worry and children's symptoms related TO kindergarten or to school IEQ reported by parents in the National survey on indoor air

their child more ill than parents without health-related preoccupation and, further, that parental health-related worries had a weak association with child's own symptom reports.<sup>19</sup> A study conducted in a similar school survey dataset as used in our study showed that parental health worries toward IEQ may in some cases partially explain the association between IEQ and symptom reporting.<sup>25</sup> While further prospective studies are still clearly needed, our results are in line with those findings. Further, to a degree, parental worry of their child's health is normal. However, as parents' IEQ-related health worry results in interpreting their children more ill, it might also shape parent's health behavior toward child's symptoms. Parental behavior toward children has shown to influence their child's health attitudes and behavior and even modify child's health outcomes in later life course.<sup>31</sup> Thus, parental preoccupation with IEQ-related adverse health effects could increase their health-seeking behavior on behalf of their children but also shape children's illness behavior as they learn by modeling from parents.

Our results contribute to the earlier studies by showing that parents' health perceptions associate with IEQ-related symptom reports on children. The observed effects were strong, much stronger than are typically seen with indoor air factors<sup>6,7,26</sup> and remain robust when the parent's and child's allergic diseases were taken into account in the additional analyses. This supports the suggestion by Marmot et al.<sup>10</sup> that at least in some situations the physical environment is less important than psychosocial factors in explaining IEQ-related symptom reports.<sup>10,47</sup> Perceived environmental health risks have been shown to associate with increased symptom reports in adults and adolescents<sup>24,32,33</sup> so that psychosocial factors such as perceived health risks influence ways how individuals interpret somatic information and result in diminished accuracy in symptom reports.<sup>34-36,47,48</sup> Also, it is shown that health perceptions modify health outcomes independently of the physiological measurements of the body.<sup>34,35,37-40</sup> Thus, if parents' health perceptions create expectations for symptoms, it might, in turn, decrease the accuracy



**TABLE 4** Multivariate adjusted predictors of child's indoor environment quality (IEQ)-related symptoms at kindergarten or at school during past 12 months reported by parents in the National survey on indoor air

	Unadjusted		Adjusted		Unadjusted		Adjusted		Mutually adjusted	
	cOR	95% CI	aOR	95% CI	cOR	95% CI	aOR	95% CI	aOR	95% CI
Parent's IEQ-related symptoms at workplace										
No symptoms	1		1						1	
Symptoms	4.2	[2.6, 7.0]	4.9	[2.7, 8.6]					4.0	[2.2, 7.2]
Parent's health worry related to water damage at workplace										
No or minor risk					1		1		1	
Moderate					2.2	[1.0, 5.0]	2.3	[1.0, 5.4]	1.9	[0.8, 4.5]
Severe to very severe					3.2	[1.4, 7.0]	3.0	[1.3, 7.0]	2.1	[0.9, 5.1]

N(parent's symptoms) = 589; N(parent's health worry) = 581; N(Mutually adjusted) = 570; OR, Odds ratio; CI, Confidence interval; cOR, unadjusted model; aOR, adjusted model; Models adjusted by parents' age, gender, level of education, smoking in the family, form of accommodation ownership, parent's self-reported health, and number of children in the family.

of children's symptom reporting and modify the coping with the symptoms. From practical point of view, these results are particularly important by showing that symptom reports seem sensitive for parents' health perceptions and thus those should be acknowledged in future research and practice.

Questionnaires on IEQ and related symptoms, which have been widely used in office-like work environments,<sup>41</sup> are also used to survey IEQ and health of pupils in schools. Typically, parents' reports are used as proxy for primary school pupils' symptom reporting. There are, however, discrepancies between parents' proxy reports and children's self-reports on symptoms.<sup>42</sup> We have earlier shown that children aged 9–12 years can provide reliable information about their symptoms<sup>45</sup> and that there are no large differences in the associations of IEQ factors with symptoms reported either by child or the parent.<sup>26</sup> Self-administered questionnaires are also easier to administer to pupils in schools than to their parents, which yields clearly higher response rates. In the present analyses, parent's own symptoms and health worry had a clearly stronger effect on child's symptoms reported by the parent than by the child itself. This finding further supports the use of child-administered questionnaires about child's symptoms and health perceptions in line with earlier studies.<sup>43–45</sup>

Our study has several strengths. Firstly, we used two independent datasets of parents' IEQ-related symptoms and health perceptions showing consistent results. Findings are strengthened methodologically by the fact that we assessed the associations of parents' and children symptoms attributed to different environmental sources (school IEQ in children versus workplace or moisture and water damage in buildings in parents). To continue, the additional analyses showed similar and even stronger associations between parental IEQ-related health worry and proxy-reported child's symptoms than those reported in main analyses, suggesting robust associations between IEQ-related health worry and symptom reports. Our school study enabled us to take into account the condition of school buildings, but adjustment for its estimated IEQ status did not change the results. Further, analyses conducted in the general

population-based dataset showed robust results even after adjusting for parents' self-reported health that is formerly shown strongly to shape parental reporting of their child's health.<sup>46</sup>

The study also has limitations. Firstly, we have only limited information of respondents' current health conditions and medical history as clinical evaluation for parents' or children's were not done. Second, we cannot fully evaluate the effect on the current results of the very large number of social, familial, psychological, or biological factors, including shared genetic predisposition, which could modify susceptibility to IEQ-related health problems. The results remained, however, practically unchanged after adjusting for several socioeconomic and other factors, including children's and parents' allergic diseases and asthma, which could be interpreted to partially reflect shared genetic and environmental factors. Therefore, we suggest that it is unlikely that these factors would have a major effect on the association seen in this study. Third, an estimated 8% to 13% of the data consisted of parent-child dyads, where the parent had filled in the questionnaire for several siblings in the school study. As no personal identification data were collected from the parents, we were unable to account for this by using multilevel modeling. This would have slightly widened the confidence intervals, but would not have affected the effect estimates and, most likely, the conclusions drawn. Fourth, parents' response rate in the school survey was low but it should be noted that we replicated the findings in the National survey with better response rate. Fifth, we were unable to take into account teachers' awareness of IEQ problems and attitudes toward IEQ-related health effects in the school study. As children answered the questionnaire under teacher supervision, teachers' attitudes may have influenced the responses. Finally, a limitation for this study was the use of a fairly short and non-validated assessment method for IEQ-related health worries and related factors, which does not allow us to explore the mechanisms of IEQ-related health perceptions. Future studies should use more comprehensive measurements to cover the dimensionality of health-related worries including thoughts, feelings, behavior, and impact on daily lives to validate the mechanisms and processes of the IEQ-related health worries on health.



## 5 | CONCLUSION

This study shows that parent's IEQ-related symptoms and health worry associate strongly with child's symptoms reported especially by the parents, but weaker associations were seen also with symptoms reported by the children themselves. These results remained robust even when IEQ in building or parents' and children's allergic diseases indicating for shared health-related risk factors for IEQ-related adverse health effects were taken into account. So far parents' health perceptions on children's symptoms and health have been little studied and considered in environmental issues. To conclude, our results suggest that parents' health perceptions increase the reporting of IEQ-related symptoms in their children. These findings have important implications on how to interpret child's symptoms and support the use of indoor air questionnaires administered directly to the children. Further research is still needed to determine how parental health behaviors influence children's symptoms and health in indoor environmental issues.

## CONFLICT OF INTEREST

None declared.

## AUTHOR CONTRIBUTIONS

Sanna Selinheimo: Conceptualization (supporting); Formal analysis (supporting); Investigation (equal); Methodology (supporting); Visualization (lead); Writing—original draft (lead); Writing—Review and Editing (lead); Jussi Lampi: Conceptualization (supporting); Data curation (equal); Formal analysis (lead); Investigation (equal); Methodology (equal); Writing—original draft (supporting); Writing—Review and Editing (supporting); Juha Pekkanen: Conceptualization (lead); Data curation (equal); Formal analysis (supporting); Funding acquisition (lead); Investigation (equal); Methodology (equal); Writing—original draft (supporting); Writing—Review and Editing (supporting).

## ETHICAL APPROVAL

The research plans were approved by the Institutional Review Board (IRB) of National Institute for Health and Welfare (THL), Finland (THL/1370/6.02.01/2016), for the questionnaire survey in schools in Helsinki study and (THL/1563/6.02.01/2018) for the National survey on Indoor air.

## ORCID

Sanna Selinheimo  <https://orcid.org/0000-0003-0563-9017>

Juha Pekkanen  <https://orcid.org/0000-0002-1083-8777>

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## SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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